

Figure 8.--Calcium concentration

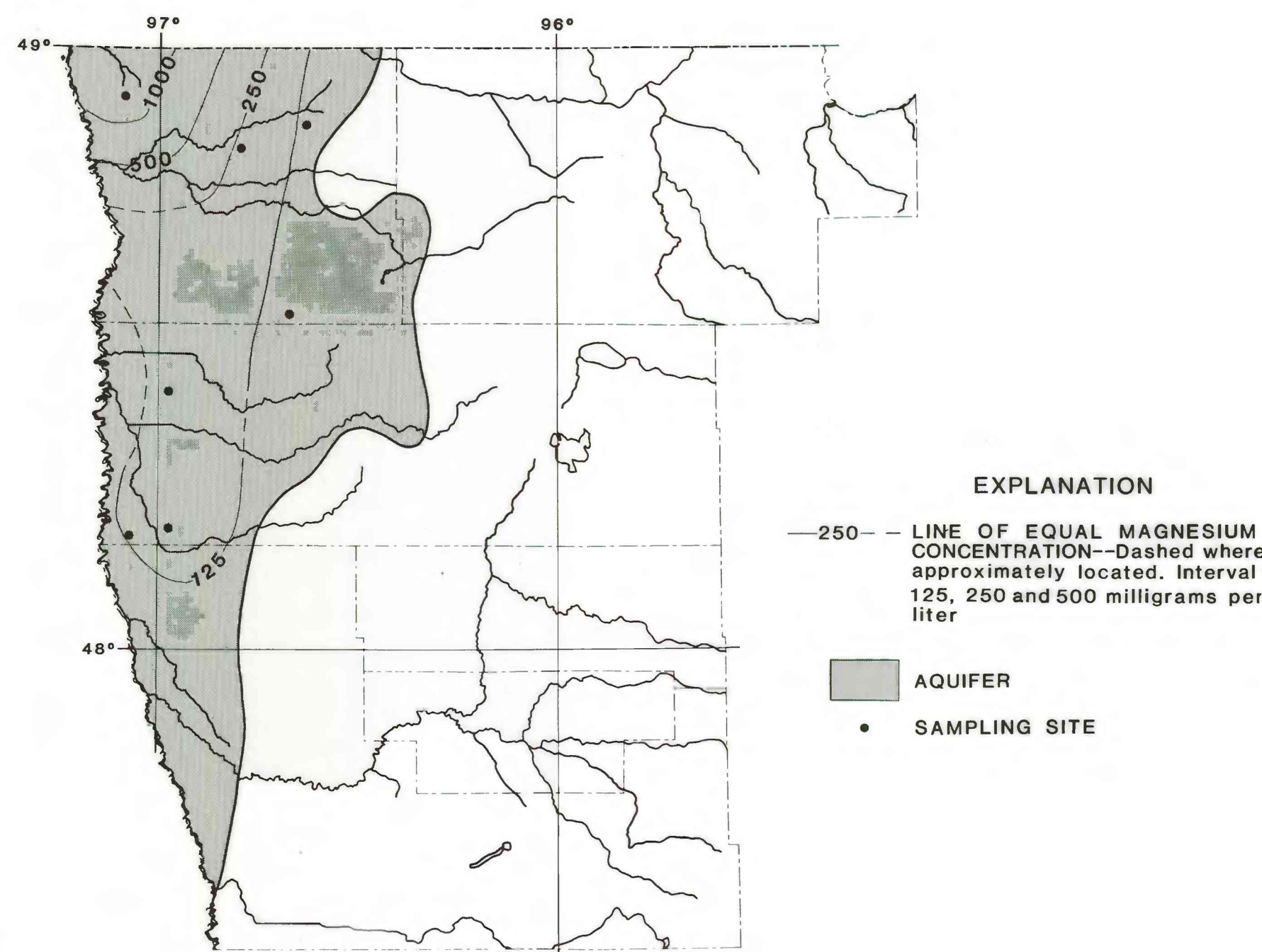


Figure 9.--Magnesium concentration

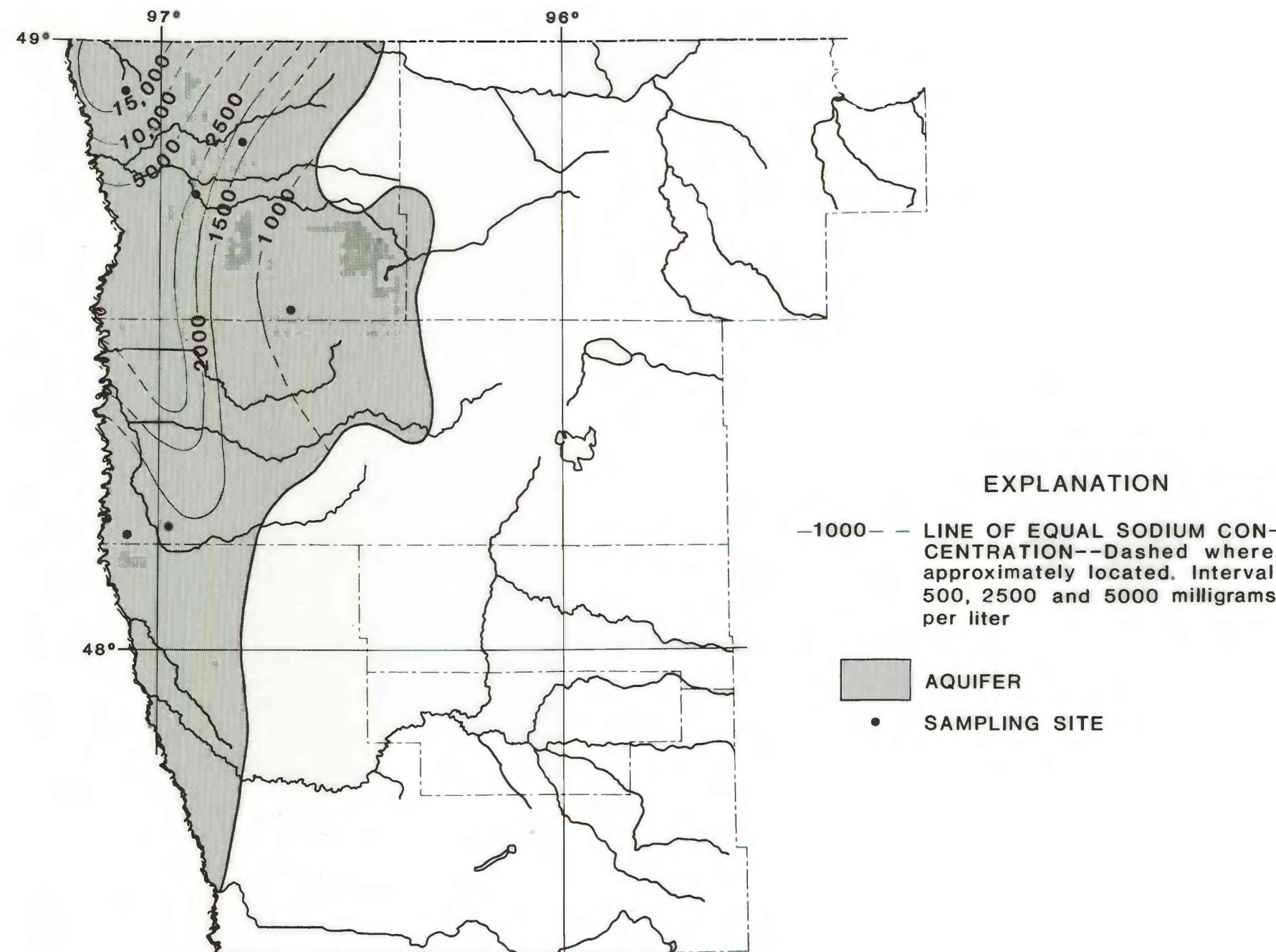


Figure 10.--Sodium concentration

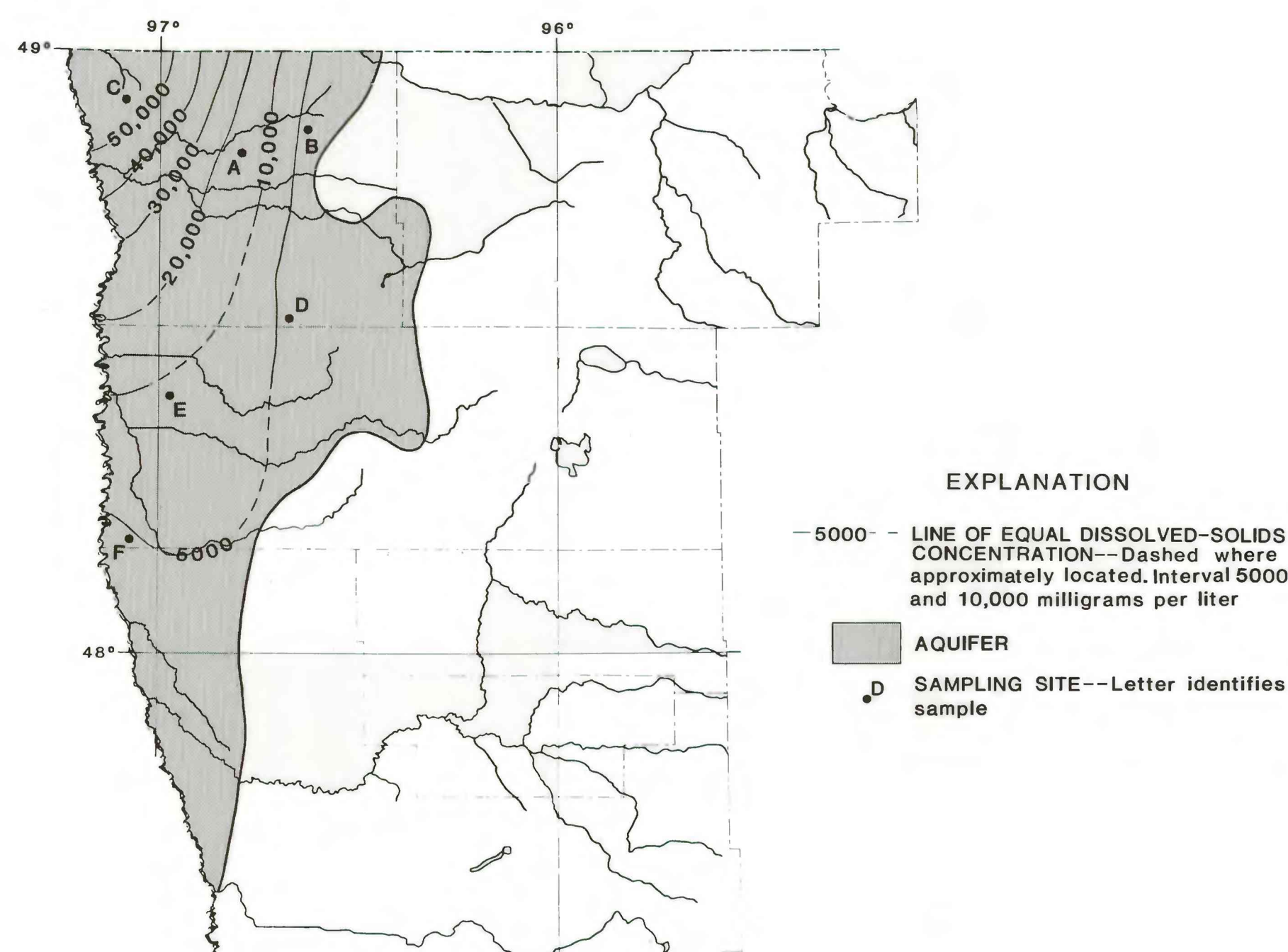


Figure 6.--Dissolved-solids concentration

Dissolved Solids

Dissolved-solids concentration is commonly used as a guideline to assess suitability of water for various uses. A dissolved-solids concentration less than 500 mg/L generally is considered to be satisfactory for domestic and most industrial uses. However, dissolved-solids concentrations in the aquifer range from about 3,000 mg/L in the eastern part to about 60,000 mg/L in the northwest corner of Minnesota (fig. 6).

Major Ions

Water from the Red River-Winnipeg aquifer is predominantly a sodium chloride type (fig. 7). The highly saline water from the aquifer moves upward into parts of the overlying drift (Macley and Winter, 1967). The major ions generally increase in concentration toward the northwest corner of Minnesota (figs. 8-13).

WATER QUALITY

The quality of water in the Red River-Winnipeg aquifer is considered to be poor because of the high dissolved-mineral content. The eastward movement of highly mineralized water from Ordovician rocks in North Dakota into the aquifer and the high solubility of minerals in the aquifer account for the high salinity (Macley and Winter, 1967). The water-type diagram and maps showing concentration of dissolved solids and major ions are based on samples collected by the U.S. Geological Survey from about 1952 to 1956, except for one site that was tested in 1932. A summary of representative analyses for selected sites is given in table 2.

Table 2.--Water-quality analyses of samples collected from the Red River-Winnipeg aquifer¹

Constituent or property	Well number ²					
	A	B	C	D	E	F
Specific conductance (umhos/cm at 25°C).....	19,900	61,200	---	---	14,600	6,910
pH (unit).....	7.2	6.9	---	---	7.3	7.5
Temperature, water (°C).....	9.4	---	---	---	---	---
Hardness as CaCO ₃	2,400	8,040	8,410	---	1,440	950
Noncarbonate hardness.....	2,210	7,900	---	---	1,210	761
Calcium, dissolved (Ca).....	589	2,030	---	95	296	220
Magnesium, dissolved (Mg).....	227	723	1,105	54	170	98
Sodium, dissolved (Na).....	3,680	13,300	16,490	825	2,680	1,080
Potassium, dissolved (K).....	84	223	379	14	45	24
Bicarbonate (HCO ₃).....	237	174	1,400	168	216	230
Sulfate, dissolved (SO ₄).....	923	2,600	2,390	93	621	500
Chloride, dissolved (Cl).....	6,650	24,100	32,150	1,450	4,670	1,950
Fluoride, dissolved (F).....	1.0	1.4	---	1.5	1.0	0.6
Silica, dissolved (SiO ₂).....	12	6.9	---	---	---	---
Dissolved solids (total due to evaporation at 180°C).....	12,800	47,400	57,520	2,910	9,040	4,240
Nitrate, dissolved (N).....	---	---	---	0.2	2.9	1.5
Boron, dissolved (B), µg/L.....	3.0	4.7	---	1.4	3.3	2.8
Iron, dissolved (Fe), µg/L.....	4,300	---	9,000	1,600	7,200	990

¹Samples collected from 1950 through 1970.

²Sites plotted on figures 8 through 13.

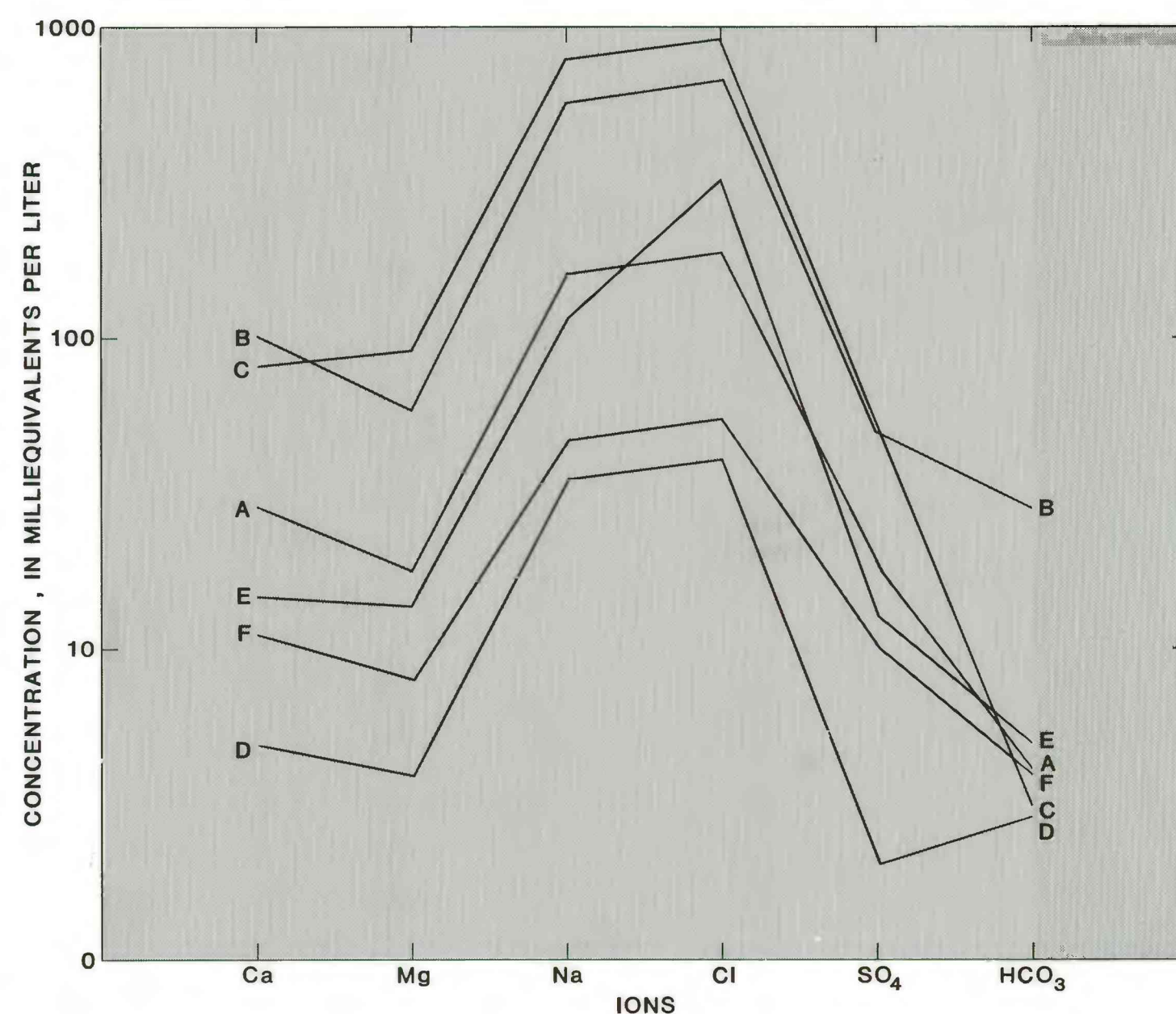


Figure 7.--Water-type patterns for six sites in the Red River-Winnipeg aquifer

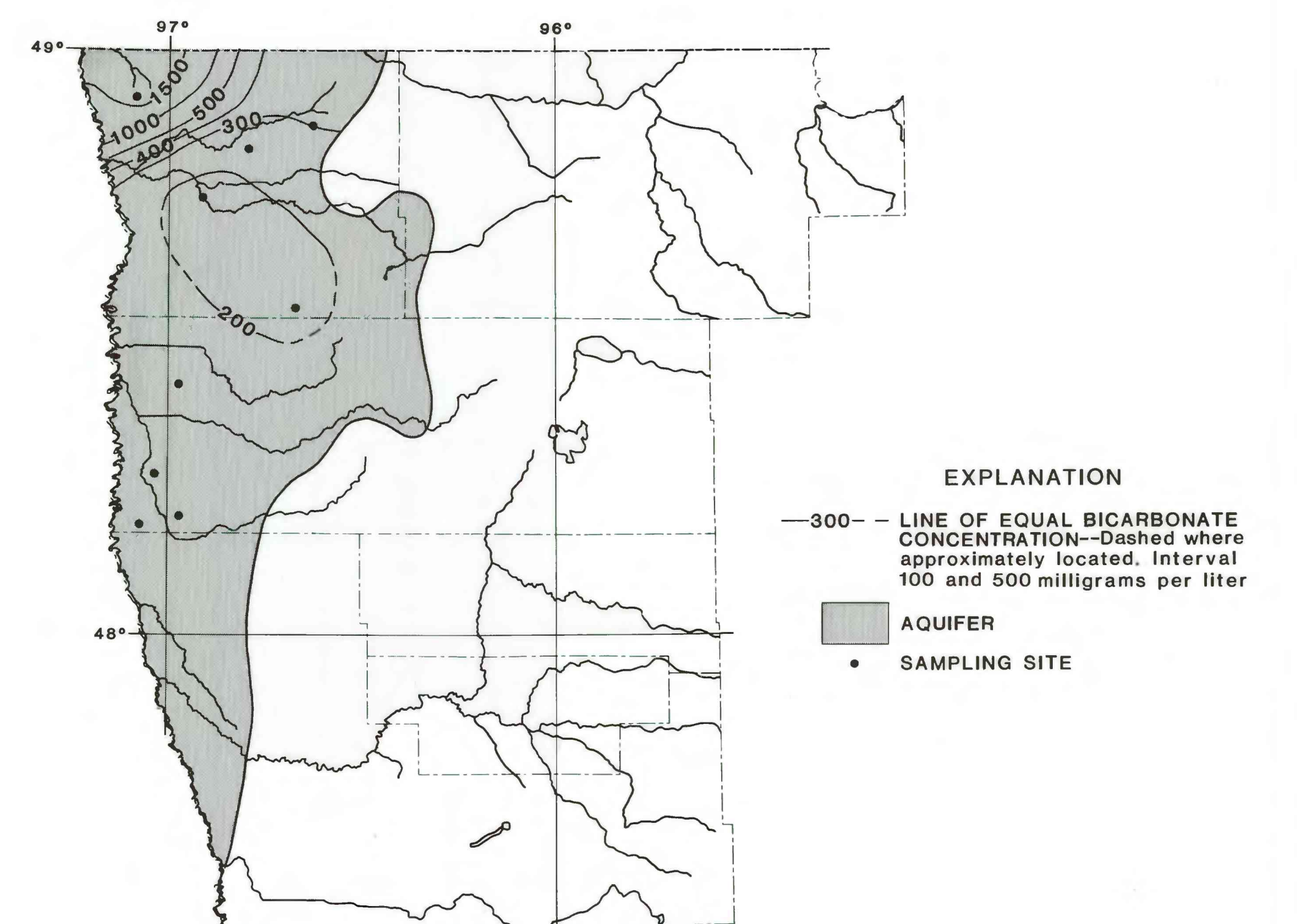


Figure 11.--Bicarbonate concentration

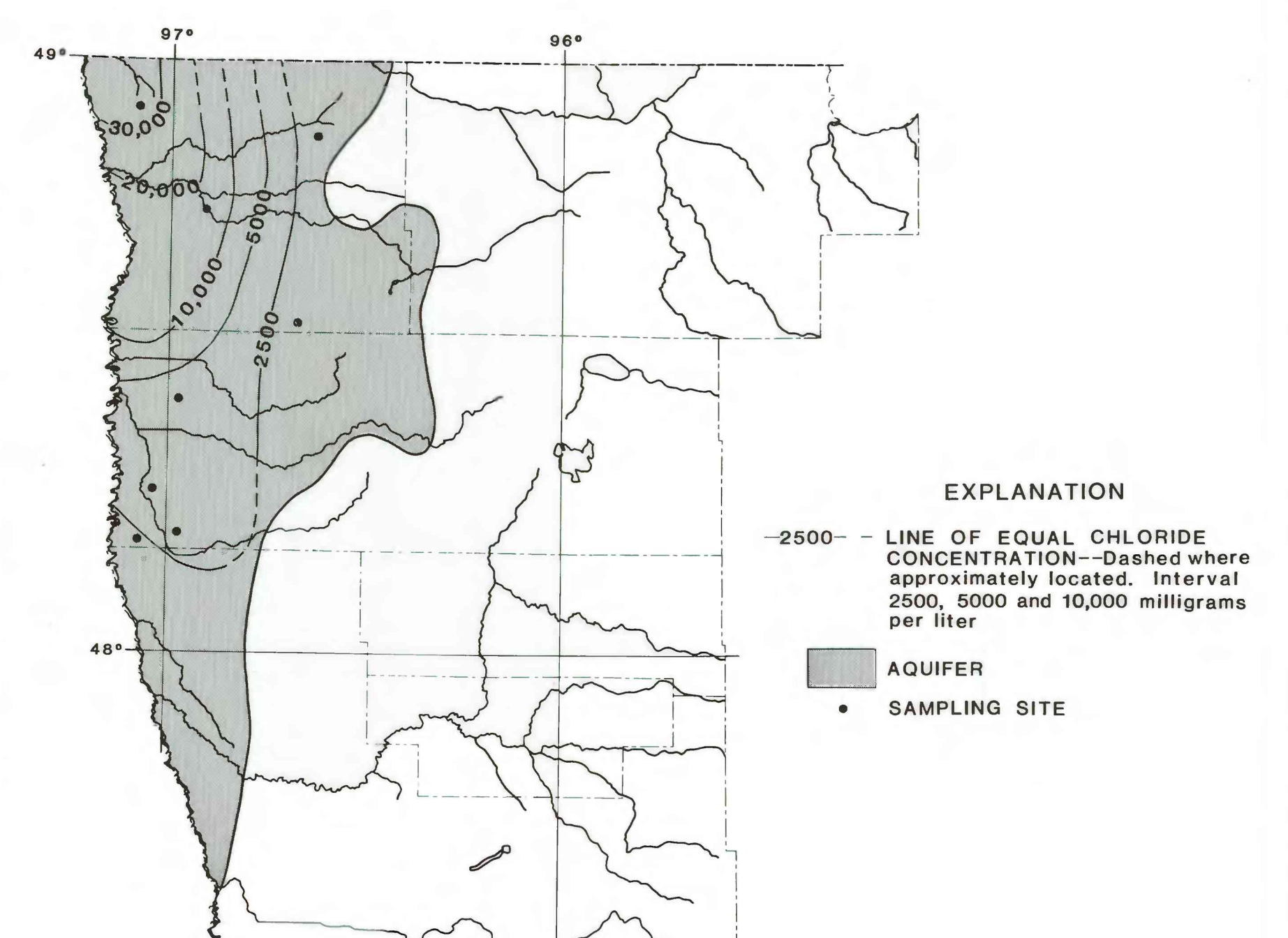


Figure 12.--Chloride concentration

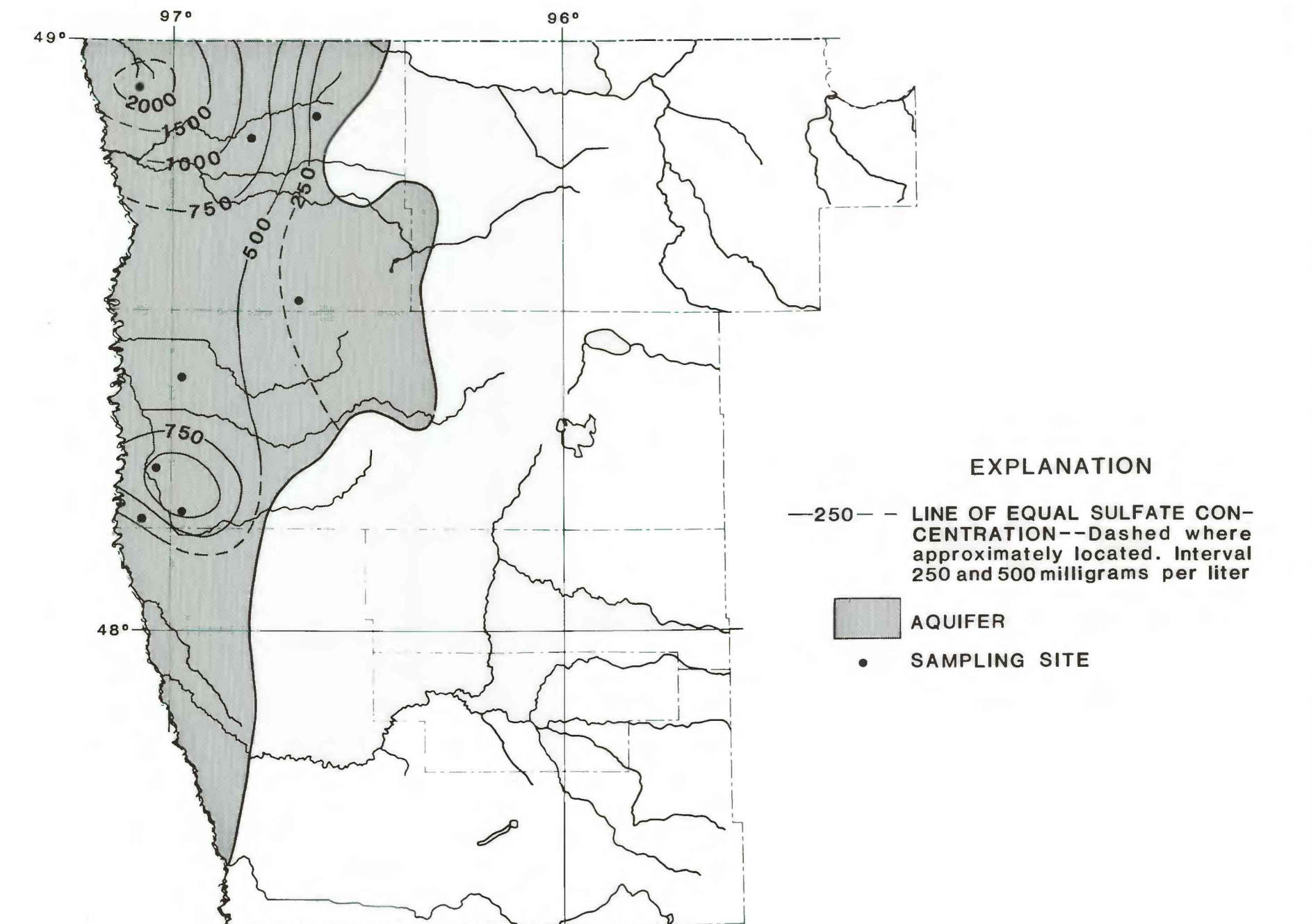


Figure 13.--Sulfate concentration

HYDROGEOLOGIC AND WATER-QUALITY CHARACTERISTICS OF THE RED RIVER-WINNIPEG AQUIFER, NORTHWESTERN MINNESOTA

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